(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 215 378 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
09.03.2005 Bulletin 2005/10

(51) Int Cl.[7]: **F02B 37/013**, F02B 37/24

(21) Application number: **01123118.0**

(22) Date of filing: **27.09.2001**

(54) **Single stage or multi-stage compressor for a turbocharger**

Ein- oder mehrstufiger Kompressor für einen Turbolader

Compresseur à un ou plusieurs étages pour un turbocompresseur

(84) Designated Contracting States:
CH DE GB LI

(30) Priority: **14.12.2000 US 737110**

(43) Date of publication of application:
19.06.2002 Bulletin 2002/25

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- **PATENT ABSTRACTS OF JAPAN vol. 007, no. 071 (M-202), 24 March 1983 (1983-03-24) & JP 57 212331 A (HITACHI SEISAKUSHO KK), 27 December 1982 (1982-12-27)**

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Description

Technical Field

[0001] The present invention relates to a turbocharger for use in an internal combustion engine, and, more particularly, to a turbocharger having a two-stage compressor.

Background Art

[0002] An internal combustion engine may include one or more turbochargers for compressing a fluid which is supplied to one or more combustion chambers within corresponding combustion cylinders. Each turbocharger typically includes a turbine driven by exhaust gases of the engine and a compressor which is driven by the turbine. The compressor receives the fluid to be compressed and supplies the fluid to the combustion chamber. The fluid which is compressed by the compressor may be in the form of combustion air or a fuel and air mixture.

[0003] A turbocharger may also include a two-stage compressor with two separate compressor wheels which are carried and driven by a common shaft coupled with the turbine. U.S. Patent No. 5,157,924 (Sudmanns) discloses a two-stage compressor with compressor wheels which are carried by a common shaft and disposed in a face-to-face manner relative to each other. The two compressors are arranged in a parallel manner such that each compressor provides an output to a charge air collecting duct in parallel. During idle or light load conditions during operation, the outlet of one of the compressors is closed so that only a single compressor provides an output to the charge air collecting duct.

[0004] With a two-stage compressor as disclosed in Sudmanns '924, the pressure ratio on the output side of the two compressors is limited since the compressors provide an output in a parallel manner to the charge air collecting duct. Moreover, stalling one of the compressors by merely closing the output therefrom may result in overheating of the compressor.

[0005] The present invention is directed to overcoming one or more of the problems as set forth above.

[0006] Further attention is drawn to the prior art document US-6,029,452, which discloses a charge air system including a small electric motor driven compressor for supplying charge air to a four-cycle internal combustion engine, including systems with turbo charger air compressors in series and parallel connection. The disclosed charge air systems can provide an effective charge air flow path to the internal combustion engine and avoids air flow restrictions at high engine operating speed.

[0007] In accordance with the present invention a turbo charger, as set forth in claim 1, an internal combustion engine, as set forth in claim 14 and a method of operating a turbo charger, as set forth in claim 21, are provided. Preferred embodiments of the invention are disclosed in the dependent claims.

Disclosure of the Invention

[0008] In one aspect of the invention, a turbocharger for an internal combustion engine is provided with a rotatable shaft. A first compressor stage includes a first compressor wheel carried by the shaft, an axially extending first inlet and a radially extending first outlet. A second compressor stage includes a second compressor wheel carried by the shaft, an axially extending second inlet and a radially extending second outlet. An interstage duct fluidly connects in series the first outlet of the first compressor stage with the second inlet of the second compressor stage. The interstage duct includes a bypass opening in communication with an ambient environment. A valve is positioned within the interstage duct. The valve is moveable to and between a first position to close the interstage duct and a second position to close the bypass opening.

[0009] In another aspect of the invention, an internal combustion engine is provided with an intake manifold and a turbocharger. The turbocharger includes a rotatable shaft. A first compressor stage includes a first compressor wheel carried by the shaft, an axially extending first inlet and a radially extending first outlet. A second compressor stage includes a second compressor wheel carried by the shaft, an axially extending second inlet and a radially extending second outlet in communication with the intake manifold. An interstage duct fluidly connects in series the first outlet of the first compressor stage with the second inlet of the second compressor stage. The interstage duct includes a bypass opening in communication with an ambient environment. A valve positioned within the interstage duct is moveable to and between a first position to close the interstage duct and a second position to close the bypass opening.

[0010] In yet another aspect of the invention, a method of operating a turbocharger in an internal combustion engine is provided with the steps of: providing a first compressor stage including a first compressor wheel carried by a shaft, and axially extending first inlet and a radially extending first outlet; providing a second compressor stage including a second compressor wheel carried by the shaft, an axially extending second inlet and a radially extending second outlet; fluidly interconnecting in series the first outlet of the first compressor stage with the second inlet of the second compressor stage with an interstage duct, the interstage duct including a bypass opening in communication with an ambient environment; positioning a valve within the interstage duct; moving the valve to a selected position between a first position closing the interstage duct and a second position closing a bypass opening; and rotating the shaft with the first compressor wheel and the second compressor wheel.

Brief Description of the Drawings

[0011]

Fig. 1 is a graphical illustration of a compressor operating map for a turbocharger having an embodiment of a multi-stage compressor of the present invention; and

Fig. 2 is a simplified, side-sectional view of an internal combustion engine including an embodiment of a turbocharger of the present invention.

Best Mode for Carrying Out the Invention

[0012] Referring now to the drawings, and more particularly to Fig. 1, there is shown an operating map for a multi-stage (i.e., two-stage) compressor 10 of turbocharger 12 shown in Fig. 2 and described in more detail hereinafter. Map 14 represents the operating behavior of compressor 10, and map 18 represents the operating behavior of compressor wheel 20 alone. Together, map 14 and map 18 define an allowable operating region of two-stage compressor 10.

[0013] In general, as the volumetric flow rate of turbocharger 12 increases as a result of increased shaft speed, the pressure ratio of turbocharger 12 likewise increases. A lower portion 24 of operating curve 22 corresponds to engine low speed conditions, an upper portion 26 corresponds to engine high speed conditions, and an intermediate portion 28 corresponds to a transition zone on operating curve 22 where the operating curve transitions from map 18 associated with compressor wheel 20 and map 14 associated with compressor wheel 16.

[0014] Line 30 represents the surge line of two-stage compressor 10. It is preferable to maintain the maximum operating curve 22 to the right of surge line 30 at all times so that surging of two-stage compressor 10 does not occur. However, as shown by the cross-hatched area 32, the portion of operating curve 22 between lower portion 24 and intermediate portion 28 does move to the left of surge line 30, thus causing surge of two-stage compressor 10.

[0015] Line 34 represents the surge line of compressor wheel 20 alone. As can be seen, operating curve 22 always stays to the right of surge line 34. The present invention advantageously operates two-stage compressor 10 as a two-stage or single stage compressor to effectively manipulate the turbocharger surge line characteristics to meet the engine operating line requirements throughout the speed/load range of the engine.

[0016] Referring now to Fig. 2, turbocharger 12 forming part of an internal combustion engine 36 will be described in greater detail. Internal combustion engine 36 generally includes turbocharger 12, exhaust manifold 38, intake manifold 40 and controller 42.

[0017] Exhaust manifold 38 receives exhaust gas from a plurality of combustion cylinders (not shown). At least a portion of the exhaust gas is directed to turbocharger 12, as indicated by line 44. Intake manifold 40 receives pressurized combustion air or an air/fuel mixture from turbocharger 12, as indicated by line 46. Intake manifold 40 is disposed in fluid communication with the plurality of combustion cylinders to provide combustion air or an air/fuel mixture thereto.

[0018] Turbocharger 12 includes two-stage compressor 10 and turbine 48. Turbine 48 is driven by exhaust gas from exhaust manifold 38. More particularly, exhaust gas flows through a variable nozzle 52, inlet duct 54 and impinges in a radial direction on turbine wheel 50. Variable nozzle 52 controls the velocity of the exhaust gas which impinges upon turbine wheel 50, thereby controlling the rotational speed of turbine wheel 50. Turbine wheel 50 is carried by shaft 56, which in turn is rotably carried by multi-part housing 58.

[0019] Compressor wheel 16 defines a first compressor wheel, and compressor wheel 20 defines a second compressor wheel. Each of first compressor wheel 16 and second compressor wheel 20 are carried by common shaft 56. Thus, rotation of shaft 56 by turbine wheel 50 in turn causes rotation of first compressor wheel 16 and second compressor wheel 20. First compressor wheel 16 and second compressor wheel 20 each face in a common direction away from turbine wheel 50, and thus are termed "forward facing" compressor wheels. First compressor wheel 16 has a diameter which is larger than second compressor wheel 20, yielding a larger pressure ratio for first compressor wheel 16 when compared with second compressor wheel 20. In the embodiment shown, first compressor wheel 16 has a diameter providing a rated pressure ratio of between 1.5:1 and 3:1 and second compressor wheel 20 has a diameter providing a total pressure ratio between about 2:1 and 3.5:1.

[0020] First compressor wheel 16 of the first compressor stage includes a first inlet 60 which receives combustion air or a fuel/air mixture, and a first outlet 62. Similarly, second compressor wheel 20 of the second compressor stage has a second inlet 64 and a second outlet 66. First outlet 62 associated with first compressor wheel 16 is connected in series with second inlet 64 associated with second compressor wheel 20 via interstage duct 68.

[0021] Plate valve 70 is positioned within interstage duct 68 and is coupled with controller 42, as indicated at reference number B. Plate valve 70 is spring biased to the first position closing interstage duct 68, as represented by arrow 78. Controller 42 selectively moves plate valve 70 between a first position (shown in solid lines) to close interstage duct 68 and a second position (shown in dashed lines) to close bypass opening 72. Plate valve 70 includes a plurality of leakage holes 74 allowing a limited amount of fluid flow therethrough when plate valve 70 is in the first position closing interstage duct 68, thereby allowing limited cooling of first compressor wheel 16.

[0022] A bypass duct 76 terminates at bypass opening 72. Bypass duct 76 is disposed in parallel with first inlet 60 of first compressor wheel 16. Bypass duct 76 allows combustion air or an air/fuel mixture to be transported into interstage duct 68 when plate valve 70 is in the first position closing interstage duct 68.

[0023] Sensors 80, 82 and 84 are each coupled with controller 42 and provide an output signal thereto, as indicated by reference letter A. Sensor 80 senses a rotational speed of shaft 56; sensor 82 senses pressure within interstage duct 68; and sensor 84 senses a volumetric flow rate of combustion air or an air/fuel mixture flowing to first inlet 60 and/or bypass opening 72. Controller 42 selectively controls a position of plate valve 70, depending upon a signal received from sensor 80, 82 and/or 84. Other engine operating parameters such as engine speed may also be sensed.

Industrial Applicability

[0024] During use, exhaust gas is transported from exhaust manifold 38 to variable nozzle 52. The diameter of variable nozzle 52 is controlled to thereby control the flow velocity of the exhaust gas flowing through inlet duct 54 and impinging upon turbine wheel 50. Turbine wheel 50 is coupled with shaft 56, which in turn carries first compressor wheel 16 and second compressor wheel 20. The rotational speed of first compressor wheel 16 and second compressor wheel 20 thus corresponds to the rotational speed of shaft 56. Depending upon the diameter of first compressor wheel 16 and second compressor wheel 20, the tangential velocity at the radial periphery thereof varies. The larger the diameter, the higher the tangential velocity at the outside diameter. The pressure ratio of first compressor wheel 16 and second compressor wheel 20 may thus be varied depending upon the selected diameter. During normal or high speed engine operation, the pressure within interstage duct 68 overcomes the spring bias against plate valve 70 and moves plate valve 70 to a second position closing bypass opening 72. Thus, two-stage compressor 10 operates using operating curve 22 associated with maps 14 and 18 (Fig. 1). During low speed or idle conditions of the internal combustion engine, the pressure within interstage duct 68 drops and a spring biased force exerted against plate valve 70 moves plate valve 70 to the first position closing interstage duct 68. The combustion air or air/fuel mixture is thus transported through bypass duct 76 to bypass opening 72, thereby allowing two-stage compressor 10 to operate as a single stage compressor utilizing only second compressor wheel 20. To ensure adequate cooling of first compressor wheel 16, a limited amount of flow occurs through leakage holes 74 in plate valve 70 within interstage duct 68. Other operating perimeters sensed by sensors 80, 82 and/or 84 may also be utilized to controllably adjust the position of plate valve 70 using controller 42.

[0025] In the embodiments shown in the drawings and described above, the valve within interstage duct 68 allowing either two-stage or single stage operation of turbocharger 12 is in the form of a plate valve 70. However, it is to be understood that other types of valves which may effectively open and close interstage duct 68 and bypass opening 72 may also be provided.

[0026] The present invention provides a turbocharger for use in an internal combustion engine with two compressor wheels which may normally be operated as a two-stage compressor. However, under certain operating conditions only a single compressor wheel is utilized to thereby provide a single stage compressor. This has the effect of shifting the surge line to the left of the operating characteristic map for the two-stage compressor, thereby effectively inhibiting surge of the turbocharger during low speed or idle conditions. The valve which is disposed within the interstage duct to effect the single stage or two-stage operation of the compressor may either be mechanically actuated (with or without overriding electronic actuation) or electronically actuated based on sensor signals associated with an operating characteristic of the internal combustion engine.

[0027] Other aspects, objects and advantages of this invention can be obtained from a study of the drawings, the disclosure and the appended claims.

Claims

1. A turbocharger (12) for an internal combustion engine (36), comprising:

   a rotatable shaft (56);
   a first compressor stage including a first compressor wheel (16) carried by said shaft (56), an axially extending first inlet 60) and a radially extending first outlet(62);
   a second compressor stage including a second compressor wheel (20) carried by said shaft (56), an axially extending second inlet (64)and a radially extending second outlet (66) ;
   an interstage duct (68) fluidly connecting in series said first outlet (62) of said first compressor stage with said second inlet (64) of said second compressor stage, said interstage duct (68) including a bypass opening (72) in communication with an ambient environment; and
   a valve (70)positioned within said interstage duct (68), said valve (70) movable to and between a first position to close said interstage duct (68)and a second position to close said bypass opening (72).

2. The turbocharger (12) of claim 1, wherein said valve (70) is spring biased.

3. The turbocharger (12) of claim 2, wherein said valve (70) is spring biased to said first position.

4. The turbocharger (12) of claim 1, including a controller (42) coupled with said valve (70) to selectively move said valve (70) between said first position and said second position.

5. The turbocharger (12) of claim 4, including a sensor (80) for sensing at least one of engine speed, volumetric flow rate of combustion air, rotational speed of said shaft (56), pressure within said interstage duct (68), absolute boost pressure and atmospheric pressure, said sensor (80) coupled with and providing an output signal to said controller (42), said controller (42) selectively moving said valve (70) dependent upon said sensor signal.

6. The turbocharger (12) of claim 1, wherein said valve (70) includes a plate.

7. The turbocharger (12) of claim 6, wherein said plate (70) includes leakage holes (74)extending therethrough.

8. The turbocharger (12) of claim 1, wherein each of said first compressor wheel (16) and said second compressor wheel (20) face in a common direction.

9. The turbocharger (12) of claim 8, including a turbine (48), and wherein each of said first compressor wheel (16) and said second compressor wheel (20) face in a common direction away from said turbine (48).

10. The turbocharger (12) of claim 1, wherein said first compressor has a pressure ratio of between about 1.5:1 and 3:1, and said second compressor has a pressure ratio of between about 2:1 and 3.5:1.

11. The turbocharger (12) of claim 1, including a turbine (48) with a variable nozzle (52) inlet, said turbine (48) connected with and driving said shaft (56).

12. The turbocharger (12) of claim 1, including at least one housing (58) defining said first inlet (60), said first outlet (62), said second inlet (64), said second outlet (66) and said interstage duct (68).

13. The turbocharger (12) of claim 12, wherein said at least one housing (58) includes multiple housing parts.

14. An internal combustion engine (36), comprising an intake manifold (40) and a turbocharger as described in claim 1.

15. The internal combustion engine (36) of claim 14, wherein said valve (70) is spring biased.

16. The internal combustion engine (36) of claim 15, wherein said valve (70) is spring biased to said first position.

17. The internal combustion engine (36) of claim 14, including a controller (42) coupled with said valve (70) to selectively move said valve (70) between said first position and said second position.

18. The internal combustion engine (36) of claim 17, including a sensor (80) for sensing at least one of engine speed, volumetric flow rate of combustion air, rotational speed of said shaft (56) and pressure within said interstage duct (68), said sensor (80) coupled with and providing an output signal to said controller (42), said controller (42) selectively moving said valve (70) dependent upon said sensor signal.

19. The internal combustion engine (36) of claim 14, wherein said valve (70) includes a plate.

20. The internal combustion engine (36) of claim 19, wherein said plate includes leakage holes (74) extending therethrough.

21. A method of operating a turbocharger (12) in an internal combustion engine (36), comprising the steps of:

providing a first compressor stage including a first compressor wheel (16) carried by a shaft (56), an axially extending first inlet (60) and a radially extending first outlet (62);
providing a second compressor stage including a second compressor wheel (20) carried by said shaft (56), an axially extending second inlet (64) and a radially extending second outlet (66);
fluidly interconnecting in series said first outlet (62) of said first compressor stage with said second inlet (64) of said second compressor stage with an interstage duct (68), said interstage duct (68) including a bypass opening (72) in communication with an ambient environment;
positioning a valve (70) within said interstage duct (68);
moving said valve (70) to a selected position between a first position closing said interstage duct (68) and a second position closing said bypass opening (72); and
rotating said shaft (56) with said first compressor wheel (16) and said second compressor wheel (20).

22. The method of claim 21, wherein said moving step includes biasing said valve (70) to said first position.

23. The method of claim 21, including the steps of :

providing a controller (42) coupled with said valve (70); and
selectively moving said valve (70) between said first position and said second position using said controller (42).

24. The method of claim 23, including the steps of:

sensing an operating parameter corresponding to at least one of engine speed, volumetric flow rate of combustion air, rotational speed of said shaft (56) and pressure within said interstage duct (68) using a sensor (80); and
selectively moving said valve (70) with said controller (42) dependent upon said sensed operating parameter.

25. The method of claim 21, wherein said valve (70) includes a plate with leakage holes (74) extending therethrough, said moving step includes moving said plate to said first position, and including the step of leaking air through said leakage holes (74).

Patentansprüche

1. Ein Turbolader (12) für einen Verbrennungsmotor (36), wobei der Turbolader Folgendes aufweist:

eine drehbare Welle (56);
eine erste Kompressorstufe mit einem ersten Kompressorlaufrad (16), das durch die Welle (56) getragen wird, und einem sich axial erstreckenden ersten Einlass (60) und einem sich radial erstreckenden ersten Auslass (62);
eine zweite Kompressorstufe mit einem zweiten Kompressorlaufrad (20), das auf der Welle (56) getragen wird, und mit einem sich axial erstreckenden zweiten Einlass (64) und einem sich radial erstrekkenden zweiten Auslass (66);
einen Zwischenstufenkanal (68), der strömungsmittelmäßig den ersten Auslass (62) der ersten Kompressorstufe mit dem zweiten Einlass (64) der zweiten Kompressorstufe in Serie verbindet, wobei der Zwischenstufenkanal (68) eine Bypass-Öffnung (72), die mit der Außenumgebung kommuniziert, beinhaltet; und
ein Ventil (70), das in dem Zwischenstufenkanal (68) positioniert ist, wobei das Ventil (70) in eine erste Position, um den Zwischenstufenkanal (68) zu schließen und eine zweite Position, um die Bypassöffnung (72) zu schließen, sowie zwischen diesen beiden Positionen beweglich ist.

2. Turbolader (12) nach Anspruch 1, wobei das Ventil (70) federvorgespannt ist.

3. Turbolader (12) nach Anspruch 2, wobei das Ventil (70) in die erste Position federvorgespannt, ist.

4. Turbolader (12) nach Anspruch 1, wobei der Turbolader eine Steuerung (42) beinhaltet, die mit dem Ventil (70) gekoppelt ist, um selektiv das

5. Turbolader (12) nach Anspruch 4, wobei der Turbolader einen Sensor (80) besitzt zum Abfühlen zumindest einer der folgenden Faktoren: Motorgeschwindigkeit, Volumenströmrate der Verbrennungsluft, Rotationsgeschwindigkeit der Welle (56), Druck innerhalb des Zwischenstufenkanals (68), absoluter Ladedruck (boost pressure) und atmosphärischer Druck, wobei der Sensor (80) mit der Steuerung (42) gekoppelt ist und ein Ausgabesignal an diesen vorsieht, wobei die Steuerung (42) selektiv das Ventil (70) in Abhängigkeit von dem Sensorsignal bewegt.

6. Turbolader (12) nach Anspruch 1, wobei das Ventil (70) eine Platte beinhaltet.

7. Turbolader (12) nach Anspruch 6, wobei die Platte (70) Leckagelöcher (74), die sich hierdurch erstrekken, beinhaltet.

8. Turbolader (12) nach Anspruch 1, wobei beide, das erste Kompressor-Laufrad (16) und das zweite Kompressor-Laufrad (20), in eine gemeinsame Richtung zeigen.

9. Turbolader (12) nach Anspruch 8, wobei der Turbolader eine Turbine (78) aufweist, wobei jede der, das ersten Kompressorlaufräder (16) und der zweiten Kompressorlaufräder (20) in eine gemeinsame Richtung weg von der Turbine (48) zeigen.

10. Turbolader (12) nach Anspruch 1, wobei der erste Kompressor ein Druckverhältnis von zwischen ungefähr 1,5:1 und 3:1 besitzt, und der zweite Kompressor ein Druckverhältnis von zwischen ungefähr 2:1 und 3,5:1 besitzt.

11. Turbolader (12) nach Anspruch 1, wobei der Turbolader eine Turbine (48) mit einem Einlass mit variabler Düse bzw. Stutzen aufweist, wobei die Turbine (48) mit der Welle (56) verbunden ist und diese antreibt.

12. Turbolader (12) nach Anspruch 1, wobei der Turbolader mindestens ein Gehäuse (58) aufweist, das den ersten Einlass (60), den ersten Auslass (62) den zweiten Einlass (64), den zweiten Auslass (66) und den Zwischenstufenkanal (68) definiert.

13. Turbolader (12) nach Anspruch 12, wobei das zumindest eine Gehäu[illegible]) mehrere Gehäuseteile beinhaltet.

14. Ein Verbrennungsmotor (36), der einen Einlassverteiler (intake manifold) (40) und einen Turbolader, wie er in Anspruch 1 beschrieben ist, aufweist.

15. Verbrennungsmotor (36) nach Anspruch 14, wobei das Ventil (70) federvorgespannt ist.

16. Verbrennungsmotor (36) nach Anspruch 15, wobei das Ventil (70) in die erste Position federvorgespannt ist.

17. Verbrennungsmotor (36) nach Anspruch 14, wobei der Verbrennungsmotor eine Steuerung (42) besitzt, der mit dem Ventil (70) gekoppelt ist, um selektiv das Ventil (70) zwischen der ersten Position und der zweiten Position zu bewegen.

18. Verbrennungsmotor (36) nach Anspruch 17, der einen Sensor (80) zum Abfühlen von zumindest einem der folgenden Faktoren aufweist: Motorgeschwindigkeit, Volumenströmungsrate der Verbrennungsluft, Rotationsgeschwindigkeit der Welle (56) und Druck innerhalb des Zwischenstufenkanals (68), wobei der Sensor (80) mit der Steuerung (42) gekoppelt ist und an diese ein Ausgabesignal vorsieht, wobei die Steuerung (42) selektiv das Ventil (70) in Abhängigkeit von dem Sensorsignal bewegt.

19. Verbrennungsmotor (36) nach Anspruch 14, wobei das Ventil (70) eine Platte aufweist.

20. Verbrennungsmotor (36) nach Anspruch 19, wobei die Platte Leckage- bzw. Ausströmlöcher, die sich hierdurch strecken, aufweist.

21. Ein Verfahren zum Betreiben eines Turboladers (12) in einem Verbrennungsmotor (36), wobei das Verfahren die folgenden Schritte aufweist:

> Vorsehen einer ersten Kompressorstufe mit einem ersten Kompressorlaufrad (16), das auf einer Welle (56) getragen wird, und mit einem sich axial erstrekkenden ersten Einlass (60) und einem sich radial erstreckenden ersten Auslass (62);
> Vorsehen einer zweiten Kompressorstufe mit einem zweiten Kompressorlaufrad (20), das auf der Welle 56 getragen wird, und mit einem sich axial erstrekkendem zweiten Einlass (64) und einem sich radial erstreckenden zweiten Auslass (66);
> Strömungsmittelmäßiges Verbinden des ersten Auslasses (62) der ersten Kompressorstufe mit dem zweiten Einlass (64) der zweiten Kompressorstufe mit einem Zwischenstufenkanal (68) in Serie, wobei der Zwischenstufenkanal (68) eine Bypass-Öffnung (72) aufweist, die mit einer Außenumgebung kommuniziert;
> Positionieren eines Ventils (70) innerhalb des Zwischenstufenkanals (68);
> Bewegen des Ventils (70) in eine ausgewählte Position zwischen einer ersten Position, die den Zwischenstufenkanal (68) schließt und einer zweiten Position, die die Bypass-Öffnung (72) schließt; und
> Rotierende Welle (56) mit dem ersten Kompressorlaufrad (16) und dem zweiten Kompressorlaufrad (20).

22. Verfahren nach Anspruch 21, wobei der Bewegungsschritt folgenden Schritt beinhaltet: Vorspannen des Ventils (70) in die erste Position.

23. Verfahren nach Anspruch 21, das weiterhin die folgenden Schritte aufweist:

> Vorsehen einer Steuerung (72), die mit dem Ventil (70) gekoppelt ist; und
> selektives Bewegen des Ventils (70) zwischen der ersten Position und der zweiten Position unter Verwendung der Steuerung (72).

24. Verfahren nach Anspruch 23, das weiterhin die folgenden Schritte aufweist:

> Abfühlen eines Betriebsparameters, der zumindest einem der folgenden Parameter bzw. Faktoren entspricht: Motorgeschwindigkeit, Volumenströmungsrate der Verbrennungsluft, Rotationsgeschwindigkeit der Welle (56) und Druck innerhalb des Zwischenstufenkanals (68) und zwar unter Verwendung eines Sensors (80); und
> selektives Bewegen des Ventils (70) mit der Steuerung (42), und zwar in Abhängigkeit des abgefühlten Betriebsparameters.

25. Verfahren nach Anspruch 21, wobei das Ventil (70) eine Platte mit Leckagelöchern (74), die sich hierdurch erstrecken, aufweist, wobei der Bewegungsschritt Folgendes beinhaltet: Bewegen der Platte in die erste Position und Durchlassen von Luft durch die Leckagelöcher (74).

Revendications

1. Turbocompresseur (12) pour moteur à combustion interne (36) comprenant :

> un arbre tournant (56) ;

un premier étage de compresseur comprenant une première roue de compresseur (16) portée par l'arbre (56), une première entrée (60) s'étendant axialement et une première sortie (62) s'étendant radialement ;
un second étage de compresseur comprenant une seconde roue de compresseur (20) portée par l'arbre (56), une seconde entrée s'étendant axialement (64) et une seconde sortie s'étendant radialement (66) ;
une conduite interétage (68) reliant, en série, la première sortie (62) du premier étage de compresseur à la seconde entrée (64) du second étage de compresseur, la conduite interétage (68) incluant une ouverture de dérivation (72) en communication avec l'atmosphère ; et
une vanne (70) disposée dans la conduite interétage (68), la vanne (70) étant mobile entre une première position pour fermer la conduite interétage (68) et une seconde position pour fermer l'ouverture de dérivation (72).

2. Turbocompresseur (12) selon la revendication 1, dans lequel la vanne (70) est sollicitée par un ressort.

3. Turbocompresseur (12) selon la revendication 2, dans lequel la vanne (70) est sollicitée par un ressort vers la première position.

4. Turbocompresseur (12) selon la revendication 1, incluant un contrôleur (42) couplé à la vanne (70) pour déplacer sélectivement la vanne (70) entre la première position et la seconde position.

5. Turbocompresseur (12) selon la revendication 4, incluant un capteur (80) pour détecter au moins l'un de la vitesse du moteur, le débit volumétrique de l'air de combustion, la vitesse de rotation de l'arbre (56), la pression dans la conduite interétage (68), la surpression absolue et la pression atmosphérique, le capteur (80) étant couplé au contrôleur (42) et lui fournissant un signal de sortie, le contrôleur (42) déplaçant sélectivement la vanne (70) en fonction du signal du capteur.

6. Turbocompresseur (12) selon la revendication 1, dans lequel la vanne (70) inclut une plaque.

7. Turbocompresseur (12) selon la revendication 6, dans lequel la plaque (70) comprend des trous de fuite (74) qui la traversent.

8. Turbocompresseur (12) selon la revendication 1, dans lequel la première roue de compresseur (16) et la seconde roue de compresseur (20) sont tournées dans une même direction.

9. Turbocompresseur (12) selon la revendication 8, incluant une turbine (48) et dans lequel la première roue de compresseur (16) et la seconde roue de compresseur (20) sont tournées dans une même direction à l'écart de la turbine (48).

10. Turbocompresseur (12) selon la revendication 1, dans lequel le premier compresseur a un taux de compression compris entre environ 1,5/1 et 3/1, et le second compresseur a un taux de compression compris entre environ 2/1 et 3,5/1.

11. Turbocompresseur (12) selon la revendication 1, incluant une turbine (48) à entrée à buse variable (52), la turbine (48) étant reliée à l'arbre (56) et l'entraînant.

12. Turbocompresseur (12) selon la revendication 1, incluant au moins un carter (58) définissant la première entrée (60), la première sortie (62), la seconde entrée (64), la seconde sortie (66) et la conduite interétage (68).

13. Turbocompresseur (12) selon la revendication 12, dans lequel ledit au moins un carter (58) inclut plusieurs éléments de carter.

14. Moteur à combustion interne (36) comprenant un distributeur d'admission (40) et un turbocompresseur selon la revendication 1.

15. Moteur à combustion interne (36) selon la revendication 14, dans lequel ladite vanne (70) est sollicitée par un ressort.

16. Moteur à combustion interne (36) selon la revendication 15, dans lequel ladite vanne (70) est sollicitée par un ressort vers la première position.

17. Moteur à combustion interne (36) selon la revendication 14, incluant un contrôleur (42) couplé à la vanne (70) pour déplacer sélectivement la vanne (70) entre la première position et la seconde position.

18. Moteur à combustion interne (36) selon la revendication 17, incluant un capteur (80) pour détecter au moins l'un de la vitesse du moteur, le débit volumétrique de l'air de combustion, la vitesse de rotation de l'arbre (56), la pression dans la conduite interétage (68), la surpression absolue et la pression atmosphérique, le capteur (80) étant couplé au contrôleur (42) et lui fournissant un signal de sortie, le contrôleur (42) déplaçant sélectivement la vanne (70) en fonction du signal du capteur.

19. Moteur à combustion interne (36) selon la revendication 14, dans lequel la vanne (70) inclut une pla-

que.

20. Moteur à combustion interne (36) selon la revendication 19, dans lequel la plaque comprend des trous de fuite (74) qui la traversent.

21. Procédé d'actionnement d'un turbocompresseur (12) dans un moteur à combustion interne (36) comprenant les étapes suivantes :

> prévoir un premier étage de compresseur incluant une première roue de compresseur (16) portée par un arbre (56), une première entrée s'étendant axialement (60) et une première sortie s'étendant radialement (62) ;
> prévoir un second étage de compresseur incluant une seconde roue de compresseur (20) portée par l'arbre (56), une seconde entrée s'étendant axialement (64) et une seconde sortie s'étendant radialement (66) ;
> connecter en série la première sortie (62) du premier étage de compresseur à la seconde entrée (64) du second étage de compresseur avec une conduite interétage (68), la conduite interétage (68) comprenant une ouverture de dérivation (72) en communication avec l'atmosphère ;
> disposer une vanne (70) dans la conduite interétage (68) ;
> déplacer la vanne (70) vers une position sélectionnée entre une première position fermant la conduite interétage (68) et une seconde position fermant l'ouverture de dérivation (72) ; et
> faire tourner l'arbre (56) au moyen de la première roue de compresseur (16) et de la seconde roue de compresseur (20).

22. Procédé selon la revendication 21, dans lequel l'étape de déplacement inclut la sollicitation de la vanne (70) vers la première position.

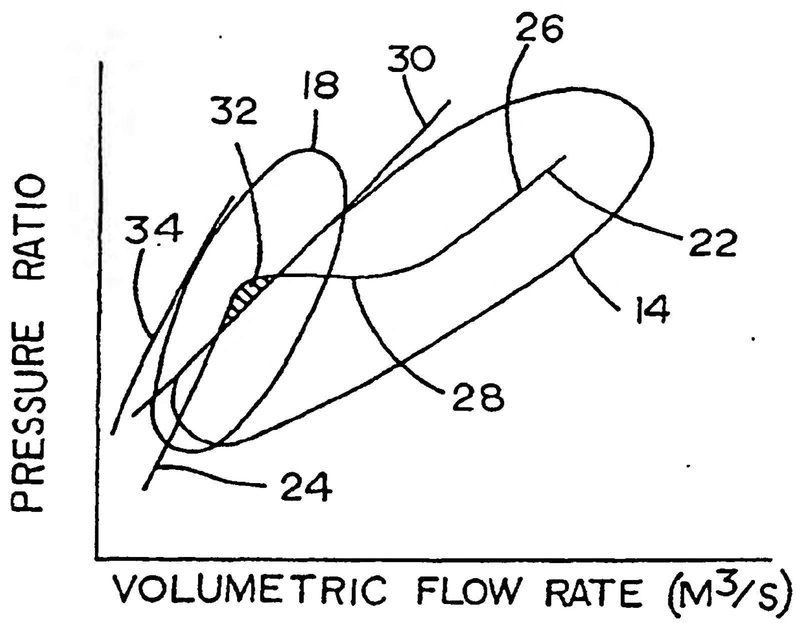
23. Procédé selon la revendication 21, incluant les étapes suivantes :

> prévoir un contrôleur (42) couplé à la vanne (70) ; et
> déplacer sélectivement la vanne (70) entre la première position et la seconde position en utilisant le contrôleur (42).

24. Procédé selon la revendication 23, incluant les étapes suivantes :

> détecter un paramètre de fonctionnement correspondant à l'un au moins des paramètres suivants : vitesse du moteur, débit volumétrique de l'air de combustion, vitesse de rotation de l'arbre (56) et pression dans la conduite interétage (68) en utilisant un capteur (80) ; et
> déplacer sélectivement la vanne (70) au moyen du contrôleur (42) en fonction du paramètre de fonctionnement détecté.

25. Procédé selon la revendication 21, dans lequel la vanne (70) inclut une plaque avec des trous de fuite (74) qui la traversent, l'étape de déplacement incluant le déplacement de la plaque vers la première position et incluant l'étape consistant à laisser fuir de l'air à travers les trous de fuites (74).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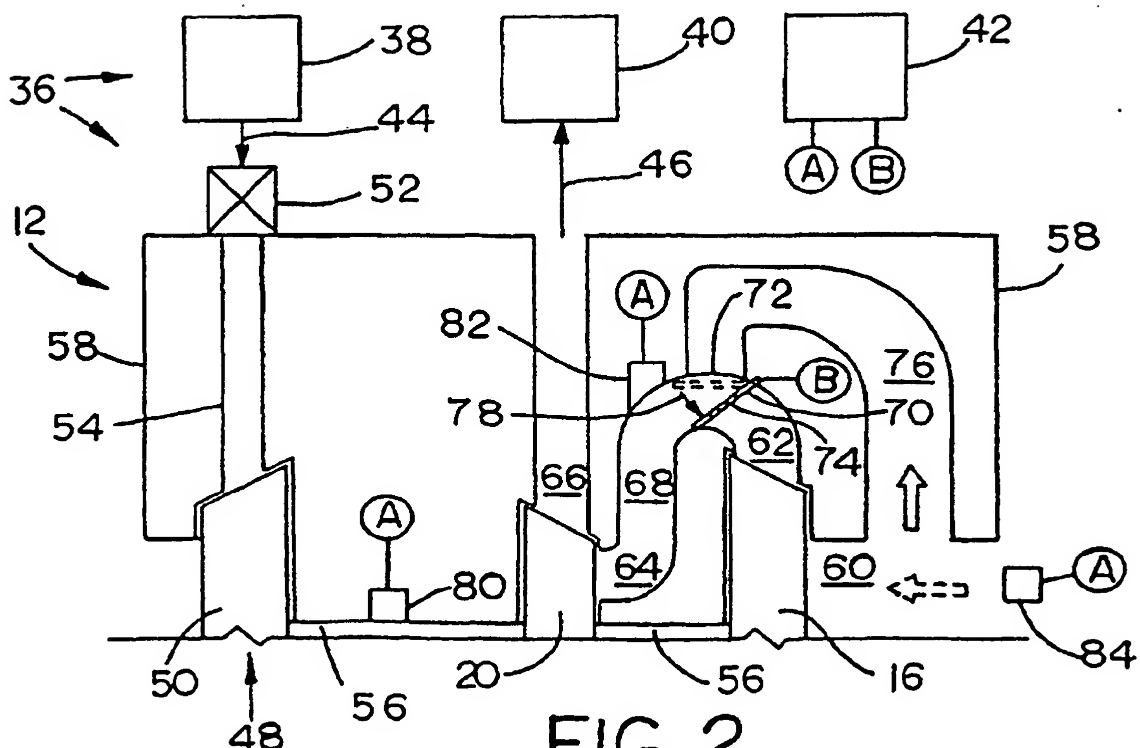
PRESSURE RATIO
VOLUMETRIC FLOW RATE (M3/S)

FIG.1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A
64
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80
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50
48
56
20
56
16

FIG.2